Review Article

Public Health Panorama of Operational Research: A Narrative Review

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Abstract

Operational research (OR) is a relatively new, applied branch of mathematics, which helps provide a scientific base for the management and problem-solving. At present, its application in public health issues is gaining importance both nationally and internationally, particularly in program management and policy making. It is an interdisciplinary team approach that requires managers and researchers to work together toward identification of the problems and implementation of optimal solutions. There is rising importance accorded by international and national agencies to invest resources in OR and guide program implementation in public health, and the global fund to fight TB, AIDS, and malaria allows up to 10% of each grant to be allocated for OR. There are multitude of research methods used in the field of health. These fields of OR, implementation research, and health system research are a source of confusion for researchers. OR may sometimes be used interchangeably with implementation research or under the subheading of health system research. OR using various qualitative and mathematical models provides solutions which are currently being applied to overcome the obstacles in health policy making and implementation. Integration of OR with monitoring and evaluation is a new paradigm in program management. This paper aims to summarize the theme, relevance, approach, methods, and applications and challenges of OR in the field of public health and how it had led to policy changes in the field of health.

Keywords: *Health system research, implementation research, operational research, research leading to policy change*

Introduction

Operational research (OR) is an applied branch of mathematics, which helps in giving a scientific base for management and apply timely and effective decisions to solve identified problems. It minimises the dangers from taking decisions by guessing or using thumb rules.[1] The usual approach is to analyse the problem in economic terms and then execute the solution, provided it does not hamper other humanitarian, social, and political aspects.[1,2] In context of public health, policy makers are provided with information that helps them to improve the program performance and decide the best among various service delivery strategies, identify constraints in interventions, diagnostics as well as therapeutics. This helps find the solutions to problems that restrict program quality, decrease its efficiency and effectiveness, and to determine alternative service strategies that would yield better outcome.[2] In easy words, it can be called as "the science of better."

This quantitative approach also takes into account the qualitative or judgmental elements that almost always exert a considerable impact on managerial decision-making. On the contrary, the quantitative approach must modify by the experiences and creative insight of program managers. It also gives a special responsibility to the manager and makes him pursue a managerial style that needs him to consciously and systematically resolve the decision problems.[1,2]

Methods Adopted

An exhaustive literature search was done with keyword "OR" on PubMed, Medline, Google Scholar, other web-based platforms, and in the libraries. The full texts of the articles as well as books were reviewed. The articles collected were explored for the cross references and the full texts of the articles identified were sought. The information was summarized for the convenience of public health specialists and health policy makers.

History of Operational Research

OR is a "war baby." Its origin can be credited to the English military planners

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during World War II, when England had limited resources. The first problem that was solved was to decide the exact coordinates needed to drop a time bomb on submarine by an aircraft flying over it. Their efforts led to the birth of a new technique called "linear programming" which was later named as OR. Later, it was tried more extensively in business, industry, and more recently into fields such as finance, logistics, social sciences, and public health.[1,3]

Definition of Operational Research

Definition of OR depends on individual objective. To a student, OR might be a technique that will help obtain first class marks in the examination. To a businessman, it is the technique used for getting higher profits. Like this, each individual might have a different definition based on his objective. Every definition will consider one or another characteristic of OR but may not explain or give a complete picture for the same.

Andrew Fisher *et al*.[4] (1991) defined "OR is a process, a way of identifying and solving program problems. As currently applied in health, family planning, and other development programs, OR can be defined as a continuous process with five basic steps: problem identification and diagnosis; strategy selection; strategy experimentation and evaluation; information dissemination; and information utilization. The process of OR is designed to increase the efficiency, effectiveness, and quality of services delivered by providers; and the availability, accessibility, and acceptability of services desired by users."

In April 2008, a global meeting held at Geneva[5] resulted in a consensus definition of OR in context of public health as "any research producing practically usable knowledge (evidence, findings, information) which can improve implementation of a plan or program (e.g., effectiveness, efficiency, quality, access) regardless of the type of research (methodology) falls within the boundaries of OR."

Objective of Operational Research

The aim of OR is to yield a scientific basis to the decision-maker for solving problems instead of guesswork and thumb rule methods and to find a quick and timely solution, in the good interest of the organisation or company as a whole. The solution obtained is known as "optimal decision."[1] It also helps minimize the cost, maximize the profit, and productivity. From the public health perspective, it helps in deciding on choice of interventions, strategies, or tools that can enhance the quality, effectiveness, or coverage of the programs or policies for which the research is being done.[6]

Characteristics of Operational Research

In OR, scientific models are used for making decisions thus, providing scientific substitute for judgment and intuition. It is an interdisciplinary team approach to work together toward identification of the problem, development of the study design, implementation of the study, analysis, and interpretation of results.[1] It also increases the creative ability of the decision-maker by providing mathematical tools, techniques, and various models to evaluate the outcomes of various alternatives, thus helping in making better and timely decisions. While dealing with public health issues, need of mathematical models may not always be warranted, qualitative methods may also be used.[7] However, the basic concept of research into total systems which, in principle, may be converted to mathematical models should be adapted to the needs of public health.[8] A systems approach is used while dealing with problems, where the complex interplay between the entire system and the subsystems is considered and analyzed to zero down to a suitable model to solve a problem. It addresses specific problems within the programs which are under control of managers.

The process is needed when either the reason for or the solution to the problem is not self-evident. Appropriate solutions should be measurable, easy to implement, and sustainable. Once the problem and possible solutions have been identified, they may be tested to determine the efficacy of the proposed solution. Sometimes, OR is needed to determine the effectiveness of a proposed solution by comparing more than one solution in an intervention study. Designs used for this type of OR can be a quasi-experimental design, where the situation is analyzed before and after introducing the possible solution to the service delivery unit or between service delivery units with and without the proposed solution; or a randomized controlled trial where service delivery, or health outcomes, is compared between randomly assigned "experimental" and "control" groups.[9]

Before beginning the study, it is necessary to decide how its results are to be utilized. This will also determine, to some extent, the information that needs to be collected. For an instance, a study might find that one way of delivering insecticide-treated bed nets is superior to another way. Here, if the information about cost of the superior strategy was not collected, a good informed choice cannot be made. In addition, a strategy has to be developed beforehand to disseminate the results to stakeholders, in the form of a seminar if there are multiple decision-makers or stakeholders, or in a personal meeting with the decision-maker. Researchers also have to facilitate the decision-makers and stakeholders in devising ways to implement the decisions made. Regular monitoring helps in identification of shortfalls and bottlenecks in the revised programs, for which further solutions needs to be found and implemented.[10] The process of operational research is shown in Figure 1.

Real-life Examples of Operational Research in Public Health

OR may be used for improving medical care and practice, assessing workability of interventions in specific population groups or settings, and advocating for policy change. Different study designs (both descriptive and analytical) may be used for OR in context to public health. Some examples have been depicted in Table 1.

Scope of Operational Research in Public Health

In the field of public health, OR was first used in the UK in hospital planning (Bailey 1952). In India's Public

Table 1: Examples of operational research

Authors	Type of study	Objective	Results	Policy relevance
Improving medical care				
Zachariah *et al*. (2003)[11]	Cohort	To assess feasibility and effectiveness of voluntary counseling, HIV testing, and cotrimoxazole in patients with TB by use of historical controls in Thyolo, Malawi	Voluntary counseling and testing and adjunctive cotrimoxazole shown to be feasible, safe, and associated with reduced mortality in TB patients under program conditions	Helped in including HIV testing and cotrimoxazole administration in TB patients
Sai Babu *et al*.[12]	Cross-sectional	Evaluate reasons for noninitiation of t/t in smear positive pulmonary TB reported as ID in 20 districts of Andhra Pradesh, India	Of the total confirmed 685 ID, 51% were untraceable, 22% died before t/t initiation, 13.5% had other reasons (refusal of t/t, chronic case), and no data were available for 8%	Inadequate documentation of referrals, delays in treatment initiation and registration, deficiencies in address documentation were the highlighted areas for program improvement
Assessing feasibility of interventions in specific populations or settings				
Bedelu *et al*. (2007)[13]	Descriptive	To weigh ART delivery services through decentralization to primary health care clinics, including nurse-initiated treatment as opposed to physician initiated in Lusikisiki, South Africa	HIV services in Lusikisiki achieved nearly universal coverage within 2 years without compromising quality of care thus proving that a decentralized, model of antiretroviral therapy delivery based on nurses was feasible in rural South Africa	Led to policy change to allow even non-physician clinicians to administer antiretroviral therapy
Tripathy *et al*. (2010)[14]	Cluster-randomized trial	To assess effect of community mobilization through participatory women's group in improving birth outcome in tribal clusters of Jharkhand and Orissa, India	NMR was 32% lower in the intervention clusters after adjustments	Importance of involving women groups as an alternative to just having health worker to improve NMR
Advocating policy change				
Zachariah *et al*.[15]	Retrospective cohort	To analyze routine treatment outcomes of patients on antiretroviral therapy who did and did not pay for treatment in Kenya	58% higher risk of loss to follow-up associated with payment for antiretroviral therapy; antiretroviral therapy dilutions by patients who pay for treatment	Policy change occurred and antiretroviral therapy begun to be offered free of charge to all patients in Mbagathi hospital, Kenya
Varkey *et al*.[16]	Nonequivalent control quasi-experimental	To investigate the feasibility, acceptability, and cost of a new model of maternity care encouraging husband's participation in their wife's antenatal and postpartum care in ESI dispensaries in Delhi	Significant improvement was noted in FP knowledge and behavior, and higher client-provider interactions occurred in both men and women in the intervention group. Cost of implementation Rs. 50,000/ dispensary/year	On basis of the results, the model was scaled in all ESI dispensaries in Delhi

TB=Tuberculosis, ID=Initial defaulters, NMR=Neonatal mortality rate, ESI=Employee state insurance, ART=Anti retroviral theraphy, FP=Family planning

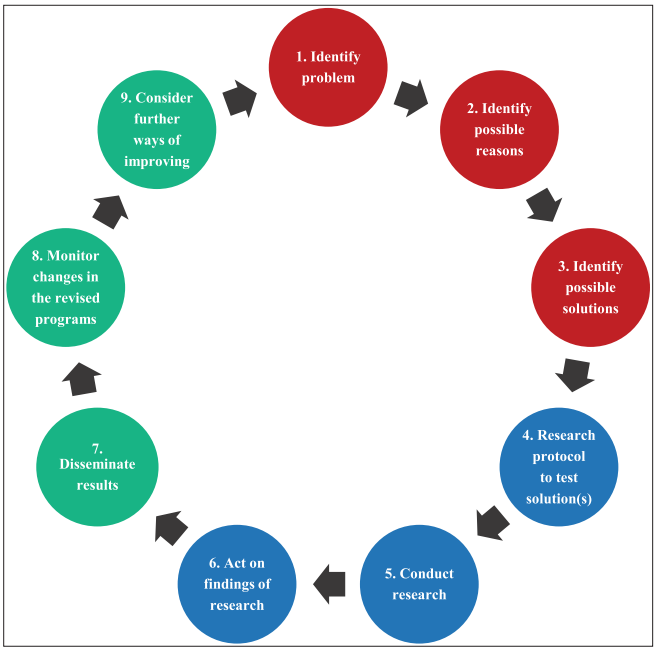

Figure 1: Flowchart of the database search, selection, and review process of articles

Health Service, it was first used by India's National Tuberculosis (TB) Institute in developing the National TB Program (1962).[1,3,8] At present, OR is utilized to bring improvements in the health system (hospital and health center management), prevention and control of various diseases (malaria, TB, HIV, other tropical diseases, communicable and noncommunicable diseases), and health and family planning programs. It can be used to address the community issues (enhance acceptability, increasing awareness, reducing stigma). By generating evidence-based solutions, OR can support the policy makers and implementers to act according to the feasible alternative strategies to yield maximum benefits. Particularly, in developing countries such as India, where optimal utilization of resources is desired, these methods can synthesize information to overcome program implementation bottlenecks in the best possible ways. OR can address any potential issues related to public health and health-care delivery system, the quality of services provided, managerial issues, and also issues at the community level.[7,17-20]

Operational Research Leading to Policy Change

There is an increasing thrust accorded by both international and national agencies to invest resources in OR and guide program implementation in public health. The global fund to fight TB, AIDS, and malaria allows up to 10% of each grant to be allocated to OR.[21,22]

In India, TB control program has been the torchbearer in the field of OR. Pioneering OR studies from India has revealed the efficacy and safety of domiciliary treatment, the importance of directly observed treatment, the feasibility of case detection through sputum smear microscopy at the lowest level of health-care facility, and also the effectiveness of intermittent short-course chemotherapy.[23] These findings have laid the foundation of directly observed treatment, short course (DOTS), which has been widely adopted by nearly 150 countries worldwide. High effectiveness and safety of ambulatory, domiciliary treatment, was demonstrated in "Madras study."[24] Another study also conducted at the TB Research Centre, Chennai, in 1958 established the need for directly observed treatment in TB.[25] In the 1960s, studies conducted at the National TB Institute (NTI), Bangalore, demonstrated that case detection through sputum smear microscopy was feasible at primary health centers.[26,27] Based on these evidences, the Indian National TB Control Program (NTP) was launched in 1962.[28] National institute for research in TB (NIRT), Chennai, in 1964 showed that an intermittent regimen and daily regimen are equally effective, making directly observed treatment more convenient.[29] After rifampicin was discovered, NIRT conducted many randomized controlled trials in the late 90s which revealed a shorter regimen of 6 months was possible if rifampicin and pyrazinamide were added to the treatment regimen, which further formed the basis of short-course chemotherapy in 1983.[30-32] Finally, the Revised National TB Control Program was implemented in pilot areas in 1993 based on the learnings of DOTS and NTP.[33,34] Majority but not all of these research work done in the field of TB bear the characteristics of OR and have been the stepping stones toward the ongoing TB program of our country.

OR has also been done in various other fields such as HIV/AIDS, malaria, and blindness. OR studies done by NACO have concluded that long distances and poor referring system are the weak areas causing hindrance in availing the services, which has led to establishment of Link Antiretroviral Therapy Centers.[35] Further research advocates expansion of link ART network.[36] Malaria is another disease of public health importance in which OR has been used extensively. Important policy decisions such as initiation of home management for malaria, introduction of LLIN's as a preventive measure was based on OR studies which had positive impact on malaria control.[37] Trachoma, an important cause for blindness, is being managed by WHO-endorsed SAFE strategy which is based on trials and is continuously being updated by OR.[38] As a result, now paramedics are conducting surgeries commonly in community, rather than ophthalmologists in hospitals, azithromycin single dose has nearly replaced the use of topical tetracycline, and improved hygiene is being promoted. Research relevant to millennium development goal (MDG) 4, 5, and 6 has also been of the current interest.[39] OR can be used in the implementation of national health mission and also in achieving MDG's and sustainable development goals. OR can be applied to various dimensions such as:

- Health-care operations: material management, quality management, queuing models, planning, etc.
- Economic analysis for optimal pricing and costing, technology assessment, and impact of policies on healthcare
- Clinical applications such as assessing risk, reaching the right clinical diagnosis, decision-making, decision support systems, disease modeling at the individual level, choosing treatment design, selecting appropriate drug and dosage, and vaccinating.

These applications can be to various health issues such as TB, HIV, poverty alleviation, and reproductive and child health. The field of OR still remains less explored in the health sector and it is sure to act as a stepping stone in policy formulation and implementation in the near future. ICMR (Indian council of medical research), OR society of India, center for operations research and training and other research organizations can contribute immensely to the health care through OR.

Operational Research Societies

A number of OR societies are operational worldwide for capacity building and skills development in the field of OR. The OR Society, International Federation of OR Societies, and Military operations research society are renowned societies worldwide. Another innovative nationally funded advisory group on patient and public involvement in research is INVOLVE which aims to support public involvement in health system in the United Kingdom. Operational Research Society of India and Center for Operations Research and Training are leading organizations in the field of OR in India. All these societies address issues relating to both health and non-health disciplines such as management, industry, forestry, and military to name a few. They conduct trainings and courses in the field of OR for improving knowledge and skills is this subject.

Challenges

OR may not always be a success; there are many constraints and challenges that may lead to the failure of such research. Individuals selected for training may not be having interest in OR or poorly qualified researchers may end up in senior management positions having no opportunity or time for research. To avoid such problems, candidates selected for the training in OR should go through a standard selection procedure and demonstrate the basic skills of research and should have propensity to solve problems. Appropriate infrastructure must be provided for the training of these candidates. Issues on research questions, study design, protocol, and maintaining the quality of data and analysis should be addressed by regular supervision and feedback. Individuals who have program experience should be oriented to develop research skills and also the concept of research fellows should be introduced into the programs who should be continuously mentored. To avoid research partnership problems, program staff should be involved at all stages. Money and staff for OR should be an integral component of long term as well as annual program planning and budgeting. Research questions should be based on identified gaps and relevant to the program. To ensure that the research findings are being translated into policy and practice, the decision-makers must be empowered as the owners of the study. In addition, the research work and program performance should be evaluated at predefined intervals by standard methodology.[6]

Conclusions

OR is a distinctive instrument leading to great benefits to health system end users at low cost. Its worth has been well-recognized nationally and internationally. Concerned efforts are required from partners and stake holders that include faculty from medical and research schools, health policy makers, program managers, epidemiologists, biostatisticians, public health specialists, and health economists who all should join hands to execute quality OR to answer public health system relevant problems and solve them timely. Furthermore, translating the outcomes into practice lead to a better health system in terms of 4A's – accessibility, affordability, availability, acceptability – bridging the prevailing disparities. OR is thus a scientifically proved efficient weapon which has previously helped in winning wars and been successfully used to overcome many implementation bottlenecks of various programs and if used appropriately with best intentions can pave our path toward the attainment of positive health.

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Conflicts of interest

There are no conflicts of interest.

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